Modeling Substorms in the Magnetotail

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We investigate the onset and consequences of reconnection in the magnetotail, related to substorms and bursty plasma flows, and discuss possible applications solar flares. Equilibrium theory demonstrates that modest perturbations of the magnetotail under mass and entropy conservation can cause the formation of thin current sheets and ultimately a loss of equilibrium. Using 2-D PIC simulations we identify the conditions that lead to the onset of collisionless tearing instability under such deformations. The subsequent dynamic evolution is modeled by 3D MHD simulations, showing the growth of reconnection with the formation of flow bursts and collapsing fields. The electric field associated with the collapsing field is the main mechanism of production of energetic particles, accelerating electrons via betatron and Fermi mechanisms, as demonstrated by test particle tracing in the dynamic MHD fields. Energy flow investigations in both PIC and MHD simulations show the relevance of compressibility, enthalpy, and Poynting flux.